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ABSTRACT

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# Title:

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# Alphanumeric and graphic facilitation effects: Instructional strategies to improve intentional learning outcomes

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Running Head: INTENTIONAL LEARNING FACILITATION

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Abstract

Two assessment endeavors were undertaken to determine the relative impact of alphanumeric and graphic instructional mediators upon intentional and incidental learning outcomes in applied instructional contexts. The intent of these investigations was to determine the feasibility of embedding strategic organizational cues within instruction to improve intentional learning outcomes in contexts where direct interactive feedback opportunities are limited. Results indicated that alphanumeric and graphic displays both provided organizational frameworks for subjects to use in immediate recall exercises, and that facilitation effects for alphanumeric and graphic displays were not maintained in delayed recall exercises.

## Introduction

Determination of the impacts of media upon learning has been an issue of considerable activity and the focus of much debate among American educational researchers. During the sixty-plus years in which such studies have been undertaken it has become clear that comparative media studies have not been able to offer clear evidence of superiority of one medium over another with regard to learning facilitation (Clark, 1983). As more and more technologies of instruction have become increasingly available for use in instructional contexts, it is increasingly less clear that there is value in identifying a hypothetically "best medium". Even as the interest in selecting an optimal medium has shifted from a product driven perspective to one which is more process driven (Wagner, 1986), interest in assessing message design efficacy for applications across media continue to grow. There appears to be a shift toward developing strategies to improve the efficiency with which instructional messages are designed so that their delivery via appropriately selected media (that is, media selected by virtue of their appropriateness for the learning/teaching task at hand) is facilitated.

Even so, the recent resurgence of interest in distance education (Moore, 1988) may have inadvertently contributed to renewed attempts to discover a "best medium" for use in distance educational endeavors. The contemporary distance educator's interest lies in developing instructional delivery systems making use interactive audio teleconferencing, audiographic teleconferencing, interactive compressed video teleconferencing, full motion video teleconferencing and interactive and asynchronous computer teleconferences to transmit "data, video and voice" in single through multi-modal delivery systems carried via satellite, coaxial cable or fiber optics. A resurgent interest in trying to identify the best medium for distance delivery applications has provided investigators with new opportunities to consider instructional delivery / instructional mediation strategies. Perhaps distance educational applications of "high tech" instructional delivery systems are to serve as a reminder that while the media carrying instructional messages may demand attention by virtue of their technological complexity, their complexity does not necessarily correlate with instructional efficiency. By focusing upon the selection and utilization of technologies of instructional delivery as the means through which instructional messages are to be transmitted, it becomes easier to focus upon instructional message design and development as a primary arena of endeavor. In order to accommodate the rapidity with which technological delivery systems are rendered obsolete, the emphasis of strategy-based investigations need to focus upon the characteristics and functions of the instructional messages being carried by means of targeted media, rather than considering simply the transmission efficacy

of the media themselves. In taking this approach, generalizable strategies generated for use across a wide variety of instructional delivery systems may be more likely to emerge.

## Discriminating the Critical from the Incidental

The ability of a novice learner to extract critical information provided by an expert in instructional situations may be hampered by the novice's inability to discriminate between those bits of information which are critical for developing a conceptual framework and those bits of information which are incidentally related to the learning task at hand. In situations where opportunities for direct interaction between expert and novice are limited, (e.g. large lecture hall instruction, teleconferenced instruction) learning to discriminate between critical and incidental information may be further hampered.

Merrill & Tennyson (1977) determined that the presentation form of information clearly affected the form of knowledge encoded in memory. Merrill's Component Display Theory (1983) proposed that secondary presentation forms can be embedded in a sequence of instruction to aid learning. Specifically, the descriptive part of the theory provided a performance content matrix for classifying instructional outcomes and primary and secondary presentation forms for describing presentation displays. The prescriptive parts of the theory provided consistency rules which suggested that learning, resulting from instruction, is most efficient and effective if combinations of primary and secondary forms are used to promote classes of performance/content outcomes (Merrill, 1987, p. 19).

Design considerations focused toward the facilitation of concept acquisition have included concerns for instructional strategies (i.e. expository, interrogatory methods of information presentation) as well as organizational and aesthetic presentation considerations. Tennyson & Cocchiarella (1986) have suggested that concept teaching can facilitate the instructional design process through the employment of instructional strategies aimed at effective formation of concept knowledge and corresponding procedural skills. Gagne's (1985) learning hierarchy states that the ability to discriminate presupposes the ability to acquire concepts; from an applied perspective, the ability to categorize and classify attributes to form concepts clearly assumes the ability to select intentional attributes from non-intentional attributes.

Use of visual display categories to facilitate concept acquisition has been included among the example/non-example design variables considered in empirical investigations. McLean, Yeh & Reigeluth (1983) found that a visual-only format was superior to either a verbal format or a visual-verbal combination when teaching conceptual relationships to high school students. McLean et al were concerned with assessing the strategic, organizational impact of visual and verbal presentation forms upon immediate and delayed recall tasks. The utilization of secondary presentation forms in conjunction with a large lecture and teleconferenced presentations appear

to be similar in intent and focus to the McLean et al study. Both the present study and the McLean et al study appear to provide a basis for establishing an organizational framework through which investigations to determine instructional efficacy of embedded secondary presentation forms may be undertaken.

Research describing message transmission/reception effects of prose and pictorial stimuli may also have direct applicability upon graphic and alphanumeric recall facilitation effects for instructional applications . Anglin (1987) has suggested that there is ample evidence to support the notion that pictures can be used to facilitate the recall of information presented in prose passages. Much of Anglin's work has been based upon Levin's (1981) theoretical framework describing functional attributes of prose-relevant pictures. Levin (1981) proposed a framework to represent seven distinct functions to be served by prose-relevant pictures. This framework included the categories of: decoration; remuneration; motivation; reiteration; representation; organization; interpretation; and transformation. Anglin (1987) proposed that the function of a representational picture is to make the information contained in a prose passage more concrete; Levin (1981) had previously suggested that representational pictures would have a moderate learning facilitation effect, while transformational pictures would make the information in a prose passage more memorable.

Even before Levin and others began looking at picture function in prose applications, researcher have investigated the impact of verbal and pictorial/imaginal systems upon memory processes. Paivio (1969) asserted that images and verbal processes function as effective alternate memory coding systems because they are closely linked to experience with concrete objects, events and language. He proposed a two-process Theory of Meaning and Mediation which suggested that there are two distinct modes of information represented in memory: a verbal mode and a visual mode. While Paivio's interest in imagery stressed imagery as informational representation in memory, his investigations provided a foundation upon which examinations of the information transmission potentials of pictures could be structured. Nelson, Reed & Walling (1976) found that memory for pictorial stimuli generally exceeded memory for their concrete labels because pictures were more likely to be encoded as both imaginal and verbal codes. They also indicated that pictorial image codes may be qualitatively superior to verbal codes when dealing with simple pictures. Pellegrino et al (1976) indicated that picture retention was superior to word retention for long-term memory, suggesting that " a dual coding position maintains that there is a separate visual and acoustic representation for the picture stimuli and only an acoustic representation for the word stimuli." (p. 535)

The purpose of the present studies was to determine the facilitative impact of alphanumeric and graphic symbols upon recall of intentional and incidental information presented in a variety of instructional contexts. Additionally, it attempted to investigate possible

contributions of alphanumeric and graphic symbols upon the reiterative and organizational functions in instructional applications. The symbolic representational systems employed in this study function directly as secondary presentation forms (Merrill, 1983); they bear a passing resemblance to Levin's (1981) prose-relevant picture functions, and may also function as cues as described by Beck (1984). The organizational strategy and delivery strategy variables described by Reigeluth & Merrill (1979) may provide a better conceptual framework for classifying the instructional variables underlying this discussion. Nevertheless, the determination of similarities between Levin's functional framework and Merrill's secondary presentation forms may ultimately provide some guidance for selecting appropriate presentation forms to elicit specific instructional outcomes.

The studies described herein took place in a large lecture instructional context and a simulated enhanced audio teleconference context. Materials employed in both contexts remained constant; assessment of immediate and delayed recall efficacy of intentional and incidental items also remained context. Specific questions to be answered as a consequence of these investigations included:

- Would the use of alphanumeric and graphic symbols in conjunction with a (taped)lecture improve subjects performance on a recall exercise?
- Would the means of transmission of the alphanumeric and graphic symbols impact performance efficacy?
- Would recall of intentionally reiterated information be facilitated over time as a consequence of exposure to either alphanumeric or graphic symbols during the encoding process?

## Method - Study 1

### Subjects

138 (23 male, 115 female) subjects were recruited from an educational technology course for pre-service teachers. Subjects were provided with extra course credit for their participation in the experimental exercise if they completed both the initial recall assessment and the delayed recall assessment one week later.

### Design

A 2 x 3 design was employed. Immediate and delayed recall was compared across graphic, alphanumeric and control groups. General recall, recall of intentional items and recall of incidental items were compared. ANOVAs were performed to determine significant differences among means scores per recall exercise per experimental conditions.

Materials

A lecture describing a hypothetical communications holding company was developed to to control for prior knowledge effects. An elaborative structure was used in the presentation of conceptual information about the company and its related subsidiaries, while information about each company was presented in an expository manner. The 7 minute, 21 second lecture was recorded on audiotape and dubbed to three separate cassette tapes to provide for identical content and information presentation in the various treatment sessions. Two sets of four overhead transparencies each were prepared to accompany the taped lecture. One set displayed line drawings in which spatial relationships described in the tape were emphasized; the other set displayed lists of alphanumeric descriptors reiterating verbal information transmitted on the tape, which presented equivalent information to that which was displayed in the graphic transparencies. Two equivalent recall tests of 24 items each were developed, one for use immediately the control / treatment conditions (Test #1) and for a one-week delayed test (Test #2) . The recall tests included 10 items dealing with information included on the verbal and graphic transparencies; these were coded as intentional recall items. The recall tests also included 10 items dealing with information which was mentioned on the audiotaped lecture, but were not visually presented either in graphic or verbal presentation modes; these were coded as incidental recall items. A demographic assessment instrument was employed to obtain descriptive information about each member in the control and experimental groups.

Procedure

All subjects reported as a group to the lecture hall in which their class was normally held. Subjects were randomly assigned to one of three groups by means of a counting off procedure. Members of each group then re-convened in a room designated per the number assigned during the counting off procedure. Group 1 (45 S's) listened to an audio tape only presentation; Group 2 (40 S's) was presented with the audiotape / graphic lesson presentation and Group 3 (53 S's) was presented with the audio tape and the verbal list presentation.

All three groups were instructed to listen to the audiotaped presentation. During the taped lecture, groups 2 and 3 were shown the transparencies respectively at appropriate, simultaneous points during the audio taped presentation, while Group 1 was provided only with the audio taped presentation. At the conclusion of the taped presentation, all subjects were instructed to complete the recall exercise (Test #1). After a delay of 1 week, subjects reported to their standard lecture hall, and as a group, individually completed recall assessment Test #2.

Results

An analysis of variance was conducted for the three groups scores on Test #1 and a repeated measures analysis was conducted for Test #2. Results showed that for Test 1 there were significant differences, $F(2, 135) = 4.34$, $p < .01$, between the control and the experimental groups when assessing general recall efficacy. Significant differences were reported for the immediate recall efficacy of intentional items, $F(2, 135) = 7.41$. $p < .01$, between the control and experimental groups. A Neuman Keuls multiple comparison confirmed that experimental groups out-performed the control group ($p < .05$) for both general recall and intentional recall tasks but that neither the graphic nor the verbal displays were superior in their facilitation effect, either for general recall, for recall of critical items or for recall of incidental items. The repeated measures ANOVA for groups' scores on Test #2 showed no significant differences among means when assessing general delayed recall, the delayed intentional recall or the delayed incidental recall.

## Method - Study 2

### Materials

The same 7 minute, 21 second taped lecture describing a hypothetical communication holding company was used in the second study. Three separate cassette tapes provided for identical content and information presentation. The same two transparencies were employed in the second study as had been used in Study 1: one set displayed line drawings in which spatial relationships described in the tape were depicted, while the other set displayed lists of verbal descriptors to present the same concepts displayed in the graphic transparencies. The same two equivalent recall tests were used , as was the same demographic assessment instrument.

### Subjects

44 (14 male, 30 female) volunteer subjects were recruited from an educational technology course for pre-service teachers. Subjects were provided with extra course credit for their participation in the experimental exercise if they completed both the initial recall assessment and the delayed recall assessment one week later.

### Procedure

Students enrolled in the pre-service teacher educational technology course were invited to participate in an (simulated) enhanced audio teleconference; they were also told that the teleconference would include an assessment exercise in which all teleconference attendees were expected to participate. Students were asked to sign up for a specific time during which teleconferences were to be conducted. Members of each group were asked to re convene in a "teleconference room" at the time selected by each participant on the sign-up sheet. Group 1 (14 S's) was provided with an audio tape only presentation; Group 2 (15 S's) was presented with

the audiotape / graphic lesson presentation and Group 3 (15 S's) was presented with the audio tape and the verbal list presentation.

At the commencement of each session, all subjects were greeted by a site facilitator and were told that further instructions would be forthcoming via an expected teleconference call. The site facilitator answered the incoming phone call; subjects were greeted by a "teleconference presentor" who described the procedures to be followed during the experimental endeavor. (The "teleconference presentor" was actually the course instructor, making the call from an office telephone just down the hall form where the subjects were convened.) Each of the three groups were told to listen to the audiotaped presentation. As in Study 1, Groups 2 and 3 were shown the transparencies respectively developed per group at appropriate, simultaneous points during the audio taped presentation by the site facilitator, while Group 1 was provided only with the audio taped presentation. At the conclusion of the taped presentation, all subjects were instructed to complete the recall exercise (Test #1). After a delay of 1 week, subjects reported to the room in which the simulated teleconference had been held; as a group, individuals completed recall assessment Test #2.

## Results

An analysis of variance was conducted for the three groups scores on Test #1 and a repeated measures analysis was conducted for Test #2. Results showed that for Test 1 there were significant differences $F(2, 42) = 3.27$, $p < .05$, between the control and the experimental groups when assessing general recall efficacy. Significant differences were reported for the recall efficacy of intentional recall items $F(2, 42) = 5.41$, $p < .01$, between the control and experimental groups. A Neuman Keuls multiple comparison confirmed that experimental groups out-performed the control group ($p < .05$) for both the general recall and the immediate recall tasks but that neither the graphic nor the verbal displays were superior in their facilitation effect, either for general recall or for recall of intentional items. There were no significant differences among experimental groups and the control group when assessing recall efficacy of the incidental recall items. The repeated measures ANOVA for groups' scores on Test #2 showed no significant differences among means when assessing general delayed recall, the delayed intentional recall or the delayed incidental recall.

## Discussion

The results of the analysis of data derived from the first study indicated that conceptual information and information describing relationships among concepts which is presented in a large lecture instructional environment is better recalled when reiterative, secondary presentation forms accompany the initial presentation. These results were maintained in the second study,

even though the context of instructional delivery had been altered from that of a large lecture to that of an audio teleconference.. The use of adjunctive facilitators such as transparencies significantly improved student performance upon a written recall exercise administered immediately after the presentation of information in both cases. There was no significant difference between alphanumeric symbol facilitation and graphic symbol facilitation when considering overall recall performance, although there did appear as if the graphic transparencies demonstrated marginal superiority in improving recall performance.

Data derived from the second study indicated that conceptual information and information describing relationships among concepts which is presented in a (simulated) audiographic teleconference is better recalled when reiterative, secondary presentation forms accompany the initial presentation. The use of adjunctive facilitators such as transparencies significantly improved student performance upon a written recall exercise administered immediately after the presentation of information. There was no significant difference between alphanumeric symbol facilitation and graphic symbol facilitation when considering overall recall performance. As in the first study, the graphic mediators demonstrated marginal superiority to the verbal mediators.

In both studies the alphanumeric and graphic displays were employed as a means of providing an organizational structure within which novice learners would be better able to discern critical information from incidental information. As such, the displays were not use to maintain attention, nor were they used to decorate or add interest to the instructional materials (Beck, 1984). Using Levin's theoretical function of prose-relevant pictures as benchmarks, one can also discern that the display forms used in these three studies did not compensate for the relative inability of verbal presentation forms to transmit information, they did not motivate subjects to recall information more efficiently, they did not represent information, they did not aid in the interpretation of information, nor did they assist in the transformation of meaning. Of course, it is also important to keep in mind that while these benchmarks provided in Levin's (1981) prose-relevant picture framework can be used in this context, they were not generated for use with both alphanumeric and graphic presentation forms. The alphanumeric and graphic display forms were used to assist in the reiteration of verbally presented information by means of secondary presentation modes, while assisting in the generation of an externally imposed organizational framework through which recall could be facilitated. Even though the instructional process is generally desribed as an interactive one, many presentation modes encourage greater dependence upon one-way transmission of information. In large lectures and in many varieties of teleconferencing, the interaction between teacher and student is implied more than it is practiced; interaction may certainly be accomodated in these presentation modes, but is not necessarily encouraged. By embedding secondary presentation forms in a sequence of instruction, they

may function as alternative representations (Van Patten, Chao & Reigeluth, 1986) through which learning, represented in this study by recall efficacy, may have been more efficient and effective.

These investigations were designed to simulate and/or replicate typical instructional situations in which opportunities for interaction and feedback were limited. For this reason, the assessment of performance outcomes elicited by means of the experimental materials occurred in two discrete instructional contexts. Even so, limitations which directly impacted attempts to simulate a true instructional situation need to be acknowledged. Actual time spent learning the taped lecture information was relatively short, and is not characteristic of typical instructional situations. Similarly, the only practice/rehearsal opportunity provided for subjects provided during the one-week delay period occurred with the administration of the first recall assessment exercise (Test #1). The lack of significance in the delayed recall assessments in both the alphanumeric or the graphic conditions was most likely due to the brevity of the treatment time. Anglin (1987) demonstrated that prose relevant picture retention has been maintained for several weeks; Mandler & Parker (1976) indicated that retention of spatial relationships from meaningful pictures can be retained for well over one week's time.

## Conclusions

The ability of a novice learner to extract critical information provided by an expert may be hampered by the novices inability to discriminate between those bits of information which are critical for developing a conceptual framework and those bits of information which are not critical. In situations where interaction may be limited it may be even more difficult to learn how to discriminate between intentional and incidental information. Immediate recall of information identified as critical and reiterated by means of alphanumeric or graphic symbols was facilitated in a large lecture context and in a simulated enhanced audio-teleconference by means of employing secondary presentation forms to reiterate critical information and to provide an organizational framework to facilitate recall of intentional information.

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